

1                   **HYPOCYCLOID REDUCING APPARATUS**

2    **BACKGROUND OF THE INVENTION**

3    1. Field of the Invention

4           The present invention relates to a revolution reducing apparatus, and  
5    more particularly to hypocycloid reducing apparatus that is quiet and compact.

6    2. Description of Related Art

7           Reducing gears, also called reducers are typically coupled to motors for  
8    reducing revolution speeds of the motors. The reducers are widely used in many  
9    engineering designs. However, the reducers today are generally applied to gears,  
10   such as planetary gears to achieve a purpose of reducing revolutions of a rotating  
11   shaft. Although, the reducing gears can change the speed of rotation to a required  
12   speed of rotation for the rotating shaft, noises will be generated during a period  
13   of the gear operating. Besides, as an arrangement of the gears in the gear reducer  
14   always occupies a huge space, the gear reducer will be bulky.

15          A hypocycloid reducing apparatus works as a speed reduction and  
16   torque multiplier mechanism that is quiet, compact and durable. However, a  
17   hypocycloid reducing apparatus is not widely used in engineering designs  
18   because few mechanical engineers understand the design principle of the  
19   hypocycloid reducing apparatus.

20          To overcome the shortcomings, the present invention provides a  
21   hypocycloid reducing apparatus to mitigate or obviate the aforementioned  
22   problems.

23   **SUMMARY OF THE INVENTION**

24          The main objective of the invention is to provide a hypocycloid reducing

1 apparatus operating as a speed reduction and torque multiplier mechanism,  
2 wherein the hypocycloid reducing apparatus is quiet, compact and durable.

3 Other objectives, advantages and novel features of the invention will  
4 become more apparent from the following detailed description when taken in  
5 conjunction with the accompanying drawings.

#### 6 BRIEF DESCRIPTION OF THE DRAWINGS

7 Fig. 1 is an exploded perspective view of a hypocycloid reducing  
8 apparatus in accordance with the present invention;

9 Fig. 2 is an operational cross sectional plan view of the hypocycloid  
10 reducing apparatus in Fig. 1 at rest;

11 Fig. 3 is a cross sectional view of the hypocycloid reducing apparatus  
12 along 3-3 line in Fig. 2;

13 Fig. 4 is an operational cross sectional plan view of the hypocycloid  
14 reducing apparatus in Fig. 1 wherein the hypocycloid reducing apparatus is  
15 mounted in a stationary base and is operating;

16 Fig. 5 is a cross sectional view of the hypocycloid reducing apparatus  
17 along 5-5 line in Fig. 4;

18 Fig. 6 is an operational cross sectional plan view of the hypocycloid  
19 reducing apparatus in Fig. 1 wherein the hypocycloid reducing apparatus is  
20 mounted in a wheel hub to drive a wheel;

21 Fig. 7 is a cross sectional view of the hypocycloid reducing apparatus  
22 along 7-7 line in Fig. 6 at rest;

23 Fig. 8 is an operational cross sectional plan view of the hypocycloid  
24 reducing apparatus in Fig. 6 wherein the hypocycloid reducing apparatus is

1 operated; and

2 Fig. 9 is a cross sectional view of the hypocycloid reducing apparatus  
3 along 9-9 line in Fig. 8.

#### 4 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

5 With reference to Figs. 1 to 3, a hypocycloid reducing apparatus in  
6 accordance with the present invention is connected to a rotating mechanism,  
7 such as a motor (50) having a driving shaft (51), to reduce a speed of revolutions  
8 of the motor driving shaft (51). The hypocycloid reducing apparatus comprises a  
9 driven input (10), an inside bracket (20), an outside bracket (30) and multiple  
10 bearings (40) including a one-directional bearing (14). One of the inside bracket  
11 (20) and the outside bracket (30) is stationary, and the other is rotatable. For  
12 convenient illustrating purpose only, the inside bracket (20) is rotatable and the  
13 outside bracket (30) is stationary in the following description.

14 The driven input (10) is coupled to the driving shaft (51) of the motor  
15 (50) and is rotated by the driving shaft (51). The driven input (10) has a proximal  
16 end (not numbered), a distal end (not numbered), an off-center assembly (not  
17 numbered), a blind hole (13) and a pivot shaft (111). The off-center assembly  
18 comprises first and second off-center members (11, 12) that are circular and  
19 located in opposite to provide a dynamic balancing to the driven input (10) as the  
20 driven input (10) is rotated, and a first actuating bearing (42) and a second  
21 actuating bearing (41) that are respectively mounted on the first and the second  
22 off-center members (11, 12). The blind hole (13) is defined in the distal end of  
23 the driven input (10) to mount and hold the one-direction bearing (14) that is  
24 coupled to the driving shaft (51). Therefore, the driving shaft (51) only can rotate

1 the driven input (10) in a given direction, and the one-directional bearing (14)  
2 will prevent the motor driving shaft (51) from being rotated in a reverse direction  
3 related to the given direction.

4 The driven input (10) is rotatably mounted in and held in the inside  
5 bracket (20) that is hollow and fitted with a bearing (43). The inside bracket (20)  
6 has a proximal end (not numbered), a distal end (not numbered), an inner space  
7 (211), an annular lip (212), multiple through holes (213), a bearing journal (214)  
8 and an output shaft (215). The inner space (211) is defined in the distal end of the  
9 inside bracket (20) to hold the driven input (10) with the bearings (41, 42, 43).  
10 The annular lip (212) is formed radially outward at the distal end of the inside  
11 bracket (20) and abuts rotatably the outside bracket (30). The through holes (213)  
12 are rectangular when viewed face on, are arranged into an annular arrangement  
13 including first and second annular configurations that are complementary and  
14 are aligned respectively with the first actuating bearing (42) and the second  
15 actuating bearing (41). Each through hole (213) receives an actuating roller, such  
16 as a cylinder (22) mounted rotatably in the through hole (213). The first and the  
17 second actuating bearings (42, 41) are respectively going to press sequentially  
18 one cylinder (22) in a corresponding of through holes (213) for an instant while  
19 the driven input (10) is rotated. The bearing journal (214) is formed near the  
20 proximal end of the inside bracket (20) to mount a bearing (44). The output shaft  
21 (215) is attached to the proximal end of the inside bracket (20).

22 The outside bracket (30) is hollow and has a passage (311) to mount  
23 co-axially the rotatable inside bracket (20). The outside bracket (30) further has a  
24 distal end (not numbered), a proximal end (not numbered), an interior periphery

1 (not numbered) with multiple lobe grooves (312) and an annular bearing groove  
2 (313) formed near the proximal end of the outside bracket (30). The output shaft  
3 (215) extends out of the passage (311) through the proximal end of the outside  
4 bracket (30). The bearing (44) is mounted on the bearing journal (214) and is  
5 held in the annular bearing groove (313) to hold rotatably the inside bracket (20)  
6 in position.

7           Consequently, when the driven input (10) is rotated by the motor driving  
8 shaft (51) about a fixed axis of rotation, the actuating bearings (41, 42) that are  
9 respectively mounted on the off-center members (11, 12) will be rotated by the  
10 rotating driven input (10). Since the off-center members (11, 12) are not  
11 concentric and are located in opposite, the rotation of all the driven input (10) is  
12 dynamically balanced. The actuating bearings (42, 41) will encounter  
13 sequentially with one cylinder (22) in the through holes (213) at a time. The  
14 actuated cylinder (22) will be pressed sequentially to encounter with one of the  
15 lobe grooves (312) that will cause a reaction force to the cylinder (22) to rotate  
16 the inside bracket (20) about an axis of revolution. The actuating bearings (42,  
17 41) will also diminish frictions during the actuating bearings (42, 41)  
18 encountering with the cylinders (22).

19           A speed reduction ratio can be calculated by a function of quantities of  
20 the cylinders (22) in one annular configuration and the lobe grooves (312).  
21 Supposing that M represents a quantity of the lobe grooves (312) and N  
22 represents a quantity of the cylinders (22) of each annular configuration, the  
23 speed reduction ration can be calculated by a fraction of a function of N and M,  
24 wherein the quantity of N is fewer than the quantity of M. In an optimized

1 condition, the quantity of N is one fewer than the quantity of M.

2           Consequently, in Figs. 1, 4 and 5, the outside bracket (30) is fixed on a  
3 stationary base (60), and the quantity of N is equal to 19 and the quantity of M is  
4 equal to 20. Thus, the resultant speed reduction ratio is calculated to be  $-19$ . The  
5 negative sign signifies that the input and out output rotations are in opposite  
6 directions. In other words, revolutions of the driven input (10) are regarded as an  
7 input rotation and revolutions of the inside bracket (20) are regarded as an output  
8 rotation. The driven input (10) that is rotated by the motor driving shaft (51)  
9 rotates the inside bracket (20) in a direction opposite to the rotation of the driven  
10 input (10) at one-nineteenth the angular movement of the driven input (10). The  
11 output speed of revolution to the inside bracket (20) is reduced by the  
12 hypocycloid reducing apparatus.

13           With reference to Figs. 6 and 7, an opposite condition is shown in that  
14 the inside bracket (20) is stationary, the outside bracket (30) is rotatable and the  
15 hypocycloid reducing apparatus is applied to drive a motorized bicycle (not  
16 shown) and is mounted in a wheel hub (70). In such a state, the output shaft (215)  
17 is adapted to be mounted securely on a fork (not shown) of the bicycle and is  
18 fixed. The outside bracket (30) is clamped by four ribs (71) of the wheel hub (70)  
19 to drive the wheel hub (70) to rotate.

20           With reference to Figs. 8 and 9, when the motor (50) starts to rotate the  
21 driving shaft (51) that rotates simultaneously the driven input (10) with the first  
22 and the second actuating bearings (42, 41), the two actuating bearings (41, 42)  
23 will encounter respectively one different cylinder (22) in sequence. Since the  
24 inside bracket (20) is fixed, the outside bracket (30) will be rotated with a

1 reduced speed of rotation to drive the wheel hub (70) that will rotate a wheel (not  
2 shown) to move the bicycle.

3 Also, since the one-directional bearing (14) is mounted between the  
4 motor driving shaft (51) and the driven input (10), the one-directional bearing  
5 (14) will prevent the motor (50) from being reversed when the bicycle is moved  
6 physically by the rider, that is, turning the pedals of the bicycle. Thus, the one-  
7 directional bearing (14) prevents possible damage to the motor (50) that might  
8 otherwise be caused by reverse rotation of the driving shaft (51).

9 Because all parts of the hypocycloid reducing apparatus in accordance  
10 with the present invention are arranged co-axially about a given axis, a size of the  
11 whole hypocycloid reducing apparatus is compact. Power transmission in the  
12 hypocycloid reducing apparatus is by means of the actuating bearings (41, 42)  
13 and the cylinders (22) so that the hypocycloid reducing apparatus is quiet during  
14 a period of operation.

15 Even though numerous characteristics and advantages of the present  
16 invention have been set forth in the foregoing description, together with details  
17 of the structure and function of the invention, the disclosure is illustrative only,  
18 and changes may be made in detail, especially in matters of shape, size, and  
19 arrangement of parts within the scope of the appended claims.